U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

TECHNICAL NOTE

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JOB ACREAGE

In order to increase the accuracy and the speed in both field and office computation of job acreage from aerial photos, the following system was developed by Don Peterson and Fred Osborne of the Vale District. In addition to the above, this system results in:

1 - Increased coordination between planning and execution stages,
2 - Reduction in difference in computations between these stages,
3 - Provides an actual and continuous record of computations at the various stages of both planning and execution,
4 - Permits adjustment of boundary lines on projects at any time, without the necessity of complete re-calculation and
5 - Gives a logical methodology to present to contractors to substantiate acreages being paid for.

The steps necessary to set this up are as follows:

Mapping of the project is the first, and one of the most critical steps in acreage computation by this method. Accuracy is extremely important and adequate accuracy is difficult to obtain without the use of a stereoscope. We use the stereo in the field in all questionable cases. Locating land section corners on the photos can best be done by use of the stereo. No inking is done on the photos themselves prior to completion of the project with the exception of corners and existing improvements. Pencil work should be done with a lead pencil as colored pencils smudge or rub off completely.

The next step following layout of the project on the photos and overlays, will be the determination of the area inside the project, as outlined on the various photos. This area, expressed in square inches can be computed with either a planimeter or with a dot grid. We use a dot grid because we feel it is easier to come up with the same answer twice, especially where there will be two, three, or even more people computing acreage on the same project at different times. Also, this method is easier to explain to contractors than are the functions of a planimeter.

Next the scale of the photo, expressed as inches per mile is determined. This is the most critical step, as a slight change in this affects accuracy of the whole photo where an error in mapping or dot counting only affects one portion. Where sufficient section corners have been located on the photos, this is done directly by reading the inches between corners to as small a scale as possible. A 50th ruler is about right, with good accuracy and easy computations.

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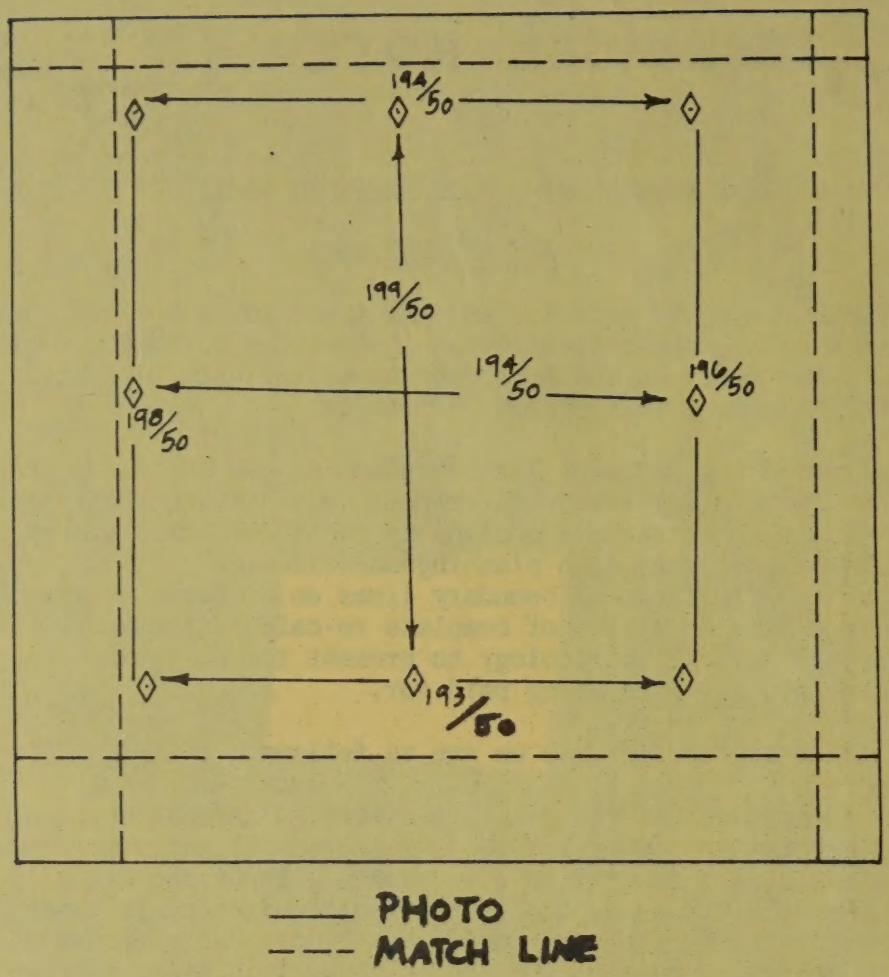
FIG 1



The distances between corners as located on photos should be averaged for that photo, and any distance that seems unusually long or short may be discarded. A scale for each photo should be determined, as every photo in the same flight line may not have the same scale.

If section corners cannot be found, scale will have to be determined by measuring a distance between two identifiable points on the photo, and on the ground. This can be done with a survey speedometer on a reasonably straight road, or by use of a chain.

Ground scale (miles) is converted to photo scale (inches) by use of a straight proportion. For example: 0.68 miles (on the ground) equals 2.32" on the photo.).68 miles is to one mile as 2.32 inches is to "x" miles.

$$\frac{0.68}{1} = \frac{2.32}{x} \longrightarrow 0.68\,x = 2.32 \longrightarrow$$

$$x = \frac{2.32}{68} \longrightarrow x = 3.4117 \text{ or } 3.41\text{" per mile.}$$

If it is not possible to use either of the above methods, it frequently is possible to convert a scale from one photo to an adjacent photo, again by use of a simple proportion. The distance between two points that can be found on both photos is measured. Any difference in distance between the two photos will be in direct proportion to the difference in scale. These points should be equal distance from the edges of each photo, or as close as possible, because of distortion.

When computing scale, try to do all work as close to the middle of the photo as possible, certainly within the match lines to keep away from distortion. Once a scale is determined, we figure an average value for each dot for that scale, in order to eliminate a step in our day to day computation.

We have been using a dot grid of 64 dots per square inch, because they are available. We feel this is adequate for most use but in some smaller, more broken patches, we feel 100 dots per square inch would be more accurate.

The acreage factor per dot is computed as follows: the inches per mile (scale of photo) is squared to obtain square inches per section. This figure is then multiplied by 64 (the number of dots per square inch) to give number of dots per section. This is in turn divided into 640 (acres per section) to get the number of dots per acre. (Fig. 1)

If we had a scale of 3.41 inches per mile, as stated above, we would plug this into the formula.

$$\frac{640}{\text{Scale}^2 \times 64} \quad \text{or} \quad \frac{640}{3.41^2 \times 64} = \frac{640}{11.6281 \times 64} = \frac{10}{11.6281} = .8599$$

or .86 dots per acre.

Therefore, the number of dots counted within a given boundary would be multiplied directly by this factor to give acreage. Both this factor and the inches per mile should be written on the photo and on the overlay. When counting dots, we count each square separately and enter that figure on a tape calculator. Upon completing a photo, we check the number of entries against the number of squares, to make sure we have not missed something. Originally we used overlays on photos just to keep the photo clean with writing being done on the overlay instead of the photo.

After using this type overlays in Operations, Don Peterson decided to super-impose a dot grid on a frosted overlay and on the overlay put the match line boundaries, scale for each photo and all found section corners for use in quick acreage computation in the field, instead of using a separate dot grid. To make a dot grid overlay, a standard acreage grid can be used (64 dots per square inch). We used 9 grids (4" x 4") cut out and taped together using Scotch Brand Magic transparent tape. This type of tape is preferable because it will not show up when zeroxed. The grids are printed on 8 1/2 x 11 inch sheets of #19-1153 drafting film. It is important to print the dots on the slick side and leave the frosted side to write on.

In printing these grids we use a zerox 2400 copyer. The drafting film has to be put through the copyer one sheet at a time. After the grids are made they can be cut to fit the photo size and then taped to the photo with masking tape or fiber tape.

Corners that were found and punched on the photos can now be put on the overlays in ink along with the job area inside the match lines. All inking should be done on the overlays except, the found corners and scale that is inked in on the back side of the photos. The scale should also be put on the overlay for convenience in figuring acres. Acres should be figured for job area inside match lines for each photo and also placed on the overlay along with the number of dots inside the match lines and the conversion factor for these dots into acres.

A work map should be made to correspond to the area outlined on the photograph overlays. The map should have all wildlife areas, hazard areas, private land and state land delineated. It is also helpful to have the photo index on this map along with the coverage boundaries of each photo. All section corners and roads in the area should be put on the map. In addition to the obvious purpose, this map is useful for coordination between crews; and we frequently give the flagmen a photo copy as well.

To use the overlay and photo together in the field is relatively simple. The attached example is an actual brush control job which we will do this spring (1969.)

The day-to-day spraying operations are hypothetical but the boundaries, section corners, and other information is exactly as it will be given to the Division of Operations by the Resource Area Conservationist. The methods of acreage and gallonage computation are done as they will be done by Operations in the field.

Using photo number 23-21-120 for an example, we arrived at a scale of 3.74 inches per mile. Plugging this into our formula, we get:

$$\frac{640}{3.74^2 \times 64} = \frac{1}{13.9876} = 0.7149 \text{ or } 0.715 \text{ acres for each dot.}$$

The number of dots, the scale, and the number of job acres within the match line area should be inked on the overlay. This will give anyone, making adjustments in the area to be treated, a chance to do so without remaking these computations. Also checking work for errors will be easier and the Division of Operations will not have to recalculate during field work.

In our example for clarity we show only calculations that would be done at the end of each period of spraying. In actual field use, this is carried farther and a "blow by blow" acreage computation is completed.

Therefore, at the end of the first morning's hypothetical spraying, our flag line is mapped in yellow. Dots are counted for each photo separately. We use a format as below, for convenience and clarity:

Period 7/27 to 11/34 - 5/4/69

Photo No.	Dots	Scale	Acres
23-21-120	81	.715	58
21-121	362	.851	235
21-122	339	.664	225
21-123	295	.685	202
		Total	720

Since the amount of gallons sprayed during this period is known, the exact application rate per acre will be known. As shown in the example, this is recorded on the overlay. This overlay will become a permanent part of the project records so that results from various applications or seeding rates can be analyzed in the future.

While this example was of a spraying operation, this method also applies to seedings and plowings as well. In addition we have found these overlays without the dots superimposed, extremely valuable for planning such things as roads, trails, fences and so forth. Following completion of these projects, which are normally subject to minor changes in location between the planning and execution stages, the exact finished location is inked on the photo by the Division of Operation. When these overlays are used, special instructions can be written on them without harming the photo.